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INTERPRETATION OF SCIENCE[1]

By Sir RICHARD GREGORY, Bart., F.R.S.

EDITOR OF *Nature*

THE address given by me last year, on "Science in the Public Press,"[2] was largely a plea for increased attention to scientific subjects in newspapers and other periodicals. It was suggested that there is a wide-spread interest in scientific discoveries and conceptions and that encouragement should be given to the production and distribution of articles in which such developments are made intelligible and acceptable to general readers. Appreciation of what is important in news of this kind requires a scientific training, while journalistic experience and a feeling for good literary style are desirable for popular treatment of the available matter. Considerations such as these are concerned in the preparation of scientific articles which will appeal to thoughtful readers among the general public.

In addition to this "literature of knowledge," there is, following De Quincey's division, the "literature of power," by which he meant poems and other writings which survive because of their beauty of expression, as distinct from information which is continually being revised and expanded. By this standard, however brilliant the exposition of a scientific subject may be, it is not considered to be what is commonly known as literature unless it represents emotional response to what is perceived or experienced. It is true that a passage from one of Sir James Jeans's books appears in the thousand pages of literary extracts included in "The Oxford Book of English Prose," but this is the

[1] Address at the twelfth annual conference of the Association of Special Libraries and Information Bureaux, London.

[2] Printed in the issue of SCIENCE for October 12, 1934.

only one representing an aspect of modern scientific thought.

In literary circles it seems to be commonly believed that the pursuit of scientific knowledge produces a cold and mechanistic type of mind altogether opposed to the throbbing and compassionate heart of life to which literature aims to respond. Even the knowledge itself is regarded superciliously because it can not claim to belong to the eternal verities. "The gods are dead," wrote W. E. Henley.

> The world, a world of prose,
> Full-crammed with facts, in science swathed and sheeted,
> Nods in a stertorous after-dinner doze!
> Plangent and sad, in every wind that blows
> Who will may hear the sorry words repeated:—
> "The Gods are dead."

It is true that the old idols of wood and stone are gone, but far nobler conceptions have taken their place. The universe no longer consists of a few thousand lamps lit nightly by angel torches, but of many millions of suns moving in the infinite azure, into which the mind of man is continually penetrating further. Astronomy shows that realms of celestial light exist where darkness was supposed to prevail, while scientific imagination enables obscure stars to be found which can never be brought within the sense of human vision, the invisible lattice work of crystals to be discerned, and the movements of constituent particles of atoms to be determined as accurately as those of planets around the sun. The greatest advances of science are made by the disciplined use of imagination; but in this field the picture conceived is always presented to nature for approval or rejection, and her decision upon it is final. In contemporary art, literature and drama, creative imagination may be exhausted, but not in science, which can provide hundreds of arresting ideas awaiting beautiful expression by pen and pencil. With one or two brilliant exceptions, popular writers of the present day are indifferent to the knowledge gained by scientific study, and unmoved by the message which science alone is able to give. Unbounded riches have been placed before them, yet they rarely raise their eyes from the primitive refuse heap. Not by their works shall we become "children of light," but by the indomitable spirit of man ever straining upwards to reach the stars.

Science needs not only writers to make its achievements intelligible to general readers, but also poetic and other interpreters who will expound its intent and influence by artistic representation or performance. It is to such literary and similar interpretations of ascertained knowledge that this address is devoted, and not to purely scientific description, however admirable and accurate this may be. Several years ago the separation of the scientific and the esthetic sides of culture was commented upon in the report of a committee of the then Prime Minister on "The Teaching of English in England," and the hope was expressed that the two might be more closely united.

> We have a traditional culture [the Committee said] which comes down to us from the time of the Renaissance, and our literature, which is rich, draws its life-blood therefrom. But the enormous changes in the social life and industrial occupations of the vast majority of our people, changes in the sixteenth century and greatly accentuated by the so-called Industrial Revolution, have created a gulf between the world of poetry and the world of everyday life from which we receive our "habitual impressions." Here, we believe, lies the root cause of the indifference and hostility towards literature which is the disturbing feature of the situation, as we have explored it. Here too lies our hope, since the time cannot be far distant when the poet, who "follows wheresoever he can find an atmosphere of sensation in which to move his wings," will invade this vast new territory, and so once more bring sanctification and joy into the sphere of common life.

Writing, at the beginning of the nineteenth century, Wordsworth similarly looked forward to the time when the poet would find inspiration in aspects of scientific achievement and industrial progress. He suggested that:

> The remotest discoveries of the Chemist, the Botanist, or Mineralogist, will be as proper objects of the Poet's art as any upon which it can be employed, if the time should ever come when these things shall be as familiar to us, and the relations under which they are contemplated by the followers of these respective sciences shall be manifestly and palpably material to us as enjoying and suffering beings. If the time should ever come when what is now called science, thus familiarised to men, shall be ready to put on, as it were, a form of flesh and blood, the Poet will lend his divine spirit to aid the transfiguration, and will welcome the being thus produced, as a dear and genuine inmate of the household of man.

The suggestion in these extracts is that poetry, like other forms of art, should follow on the heels of knowledge. During one period in the history of English poetry there was almost a total absence of intimate knowledge of natural objects and events obtained by personal observation. Nature was interpreted as gardens and green fields, with birds singing and shepherdesses dancing, but the interest was sentimental rather than scientific; that is to say, little evidence was shown of first-hand knowledge of objects and events in the world around us.

Some of the greatest poets have, however, enriched their verse by the study of natural phenomena—Lucretius, Milton, Dante and Goethe, for example, each made accurate use of the scientific knowledge of their

times. In English poetry dealing with nature—the countryside as apart from precise science—Thomson in his "Seasons" brought about a great development of interest in the natural world related to universal human nature. Even closer contact was revealed by Wordsworth, who accepted divine thought as pervading all nature and the poet as responding to the moods with which he was in close communion.

Keats and Shelley, Tennyson and Browning all saw beauty and power in nature, and each has given us works in which great poetic perceptions are mingled with passionate human feeling. Keats by perfect phrase and exalted fancy expressed the poetic love of nature for her own sake, as in his thoughts on the song of the thrush in "Nature's Child":

> O fret not after knowledge!—I have none,
> And yet my song comes native with the warmth.
> O fret not after knowledge!—I have none,
> And yet the Evening listens.

Shelley, on the other hand, in "Queen Mab," written when he was only eighteen years of age, showed himself to be acquainted with existing knowledge of the sun and stars, the structure of the universe and other astronomical studies. Similarly, Wordsworth as the contemplative lover of nature differs from Tennyson, who observed her features in minute detail and recorded them with faithful affection. In his felicitous combination of science and poetry Tennyson reveals naturalism at its highest and best. Robert Bridges in "The Testament of Beauty" similarly shows how observations of nature and science may be presented in classical literary style and illustrate that "This spiritual elation and response to Nature is Man's generic mark."

Though poetry and science represent different attitudes towards nature, they are not mutually destructive and may be complementary to one another. The purpose of poetry is not to present facts, but to express stimulating thoughts in a perfect setting of words. While science seeks to secure uniformity in verifiable truths, the essence of poetry is diversity of conception. To the scientific imagination the atom is a microcosm in which the movement of each electron plays a particular part; and it is upon the nature and consequences of the movements of such particles that attention is concentrated. The desire is to see things as they are, whereas the poet aims to display the emotional feelings aroused by them. Coleridge defined the difference between the two types of mind when he wrote: "The proper and immediate object of science is the acquirement or communication of truth; the proper and immediate object of poetry is the communication of pleasure."

The two intentions are not, however, necessarily opposed. It is common to-day to disparage Victorian verse, yet no poet has surpassed Tennyson in the application of scientific truth to poetic purpose or in his wealth of allusions arising out of a knowledge of nature's operations and laws. Interest in scientific studies increased his range of selection and opened his eyes to new phenomena and ideas. His poems abound in descriptive beauty, and though many are so well known as to have become almost trite, yet it is permissible again to quote a selection from them to show how nature knowledge may be successfully united to poetry. What a perfect picture of the last stage of metamorphosis of an insect is afforded, for example, by the words from "The Two Voices":

> To-day I saw the dragon-fly
> Come from the wells where he did lie.
>
> An inner impulse rent the veil
> Of his old husk: from head to tail
> Came out clear plates of sapphire mail.
>
> He dried his wings: like gauze they grew;
> Thro' crofts and pastures wet with dew
> A living flash of light he flew.

The constellation of Orion, which commands attention in the sky at night during winter months, approaches the setting sun as spring comes on and is eventually lost in the twilight. This is a mere statement of common observation, but in "Maud," Tennyson paints the scene with the brush of an artist;

> It fell at a time of year
> When the face of night is fair on the dewy downs,
> And the shining daffodil dies, and the Charioteer
> And starry Gemini hang like glorious crowns
> Over Orion's grave low down in the West.

There are many poetic descriptions of the midnight sky, the changing moon, morning and evening stars and other obvious aspects of the heavens, but few reveal even an elementary acquaintance with what is known of these celestial bodies. Tennyson was not only an observer, but was also familiar with current astronomical thought about the stellar universe and the formation of the solar system. The evolution of worlds by the contraction of a mass of gas is given poetic expression in several of his works, as, for example, in his notes on "The Palace of Art," where the lines appear:

> Regions of lucid matter, taking form,
> Brushes of fire, hazy gleams.
> Clusters and beds of worlds, and bee-like swarms
> Of suns, and starry streams.

Though the nebular hypothesis, which was evidently in Tennyson's mind when he wrote these lines, has had

to be revised in the light of new knowledge, his phrases are still perfect descriptions of what can be seen in the heavens.

Milton shows in many places that he was in contact with some aspects of the new philosophy of his time. Galileo's observations of mountains and plains on the moon, revealed to him through his small telescope when Milton was a child, are referred to by the poet in "Paradise Lost," where Satan's shield is compared to

> The moon, whose orb
> Through optic-glass the Tuscan artist views
> At evening from the top of Fesolé
> Or in Valdarno, to descry new lands.
> Rivers or mountains in her spotty globe.

Milton must also have known of Galileo's discovery of the true nature of the Milky Way when he beautifully described this celestial girdle as:

> A broad and ample road, whose dust is gold
> And pavement stars, as stars to thee appear,
> Seen in the galaxy, that milky way,
> Which nightly, as a circling zone, thou seest
> Powdered with stars.

Ancient philosophers speculated and disputed on the constitution of this belt of milky brightness which stretches across the sky at night, but it was not until the invention of the telescope that its true character became known. "By the irrefragable evidence of our eyes," said Galileo, "we are freed from wordy disputes upon this subject, for the Galaxy is nothing else but a mass of innumerable stars planted together in clusters."

It may justly be maintained that scientific truth is not an essential quality of good poetry, which seeks not to unveil mystery but to express it in imagery. There is thus much that appeals to those with poetic instincts in calling the Milky Way the River of Heaven, as do the Chinese and Arabs, or the Path of Souls, as do some North American Indians. Among the ancients a variety of similar beliefs prevailed, one being that a star which escaped from its appointed place set light to the whole space it passed over in its circular course, and so formed the Milky Way. These conceptions were not, however, put forward as imaginative poetry, but as philosophical explanations of what was observed. The Greek philosophers were the men of science of their day, and their ideas were often expressed in verse. Had the Greeks known that the Galaxy consists of innumerable faint stars, they would have been saved from such primitive speculations and one of their poets or philosophers might have forestalled Milton in his beautiful description of it.

It is now known that the Milky Way traces out the general shape of our star system and represents a mass of about a hundred thousand million suns. The sun, with the earth and the other planets, is at a little distance from the center of this congeries of stars, which has the shape of a flattened disk or wheel. We are looking towards the edge of the disk when we see the Milky Way, so that there is an apparent concentration of stars in the direction of the greatest extension of our stellar system. There is substantial evidence that hundreds of thousands of similar systems exist far beyond the limits of the Milky Way, so that our celestial archipelago is only one of an immense number distributed through space. The majesty of the heavens inspired the poetic genius of Job, expressed in such words as "Is not God in the height of Heaven? and behold the height of the stars, how high they are." The mind of man now comprehends a far greater universe of stars, but there has been little emotional interpretation of this wonder in poetic or other literature.

A perfect example of poetic expression applied to a common natural phenomenon is afforded by a sonnet on a shooting star which appeared some years ago in an American magazine, and impressed itself upon my memory, though the title of the magazine and name of the author have been forgotten. The appearance of a shooting star is due to a small portion of cosmic matter, often no larger than a pea, being drawn into the earth's atmosphere and being consumed through the intense heat produced by its rapid movement. In the following verse the poet, while accurately describing what occurs, brings human feeling into the expression of it, and it is his thought rather than the explanation which makes his verse beautiful.

> Far better 'tis, to die
> the death that flashes gladness,
> than alone, in frigid dignity,
> to live on high.
> Better, in burning sacrifice,
> be thrown against the world
> to perish, than the sky
> to circle endlessly,
> a barren stone.

Another fine example of the transformation of a scientific fact into poetic beauty is afforded by Francis Thompson's lines:

> All things by immortal power
> Near or far,
> Hiddenly
> To each other linkèd are,
> That thou canst not stir a flower
> Without troubling of a star.

It required a poet thus to apply the universal law of gravitation to human influences, and to touch the heart while giving a thought upon which even a mathematician may well ponder.

Poetry is not, indeed, the expression of logical

thought or scientific principle, but rather the revelation of human feeling and the art of combining words in meter and phrase which impress the mind in much the same way as music. Campbell did not want "proud philosophy" to teach him the beauty of the rainbow and Keats set forth the same doctrine that "all charms fly at the mere touch of cold philosophy," yet a poet familiar with the optics of rainbow formation might well find in them a source of inspiration. Just as emotion does not manifest itself in exactly the same way in any two minds, so every one sees a different rainbow and is the sole center of the "triumphal arch" which he sees. The particular display of colors admired by him is for him alone, and millions of raindrops falling through the air contribute to his pleasure by their refractive effect upon sunlight. To attempt to explain the formation of a rainbow in verse would not be poetry, but a literary outrage, yet the natural events which lead to a consciousness of the wonder furnish a worthy theme for a muse with poetic insight.

If the attitude presented by Keats and Campbell were true, its consequence would be to deprive every student of elementary optics of the possibility of enjoying the sight of a rainbow. It would be just as illogical to suppose that appreciation of music must be denied to all who have a knowledge of acoustics, or that when a chemist knows the constitution of a synthetic perfume he loses his sense of smell. Knowledge does not necessarily prevent poetic conceptions or strangle imaginative thought. All that it does is to place mystery on a different and a higher plane, and for a single wonder it substitutes a thousand for interpretation by poetic imagery.

It can scarcely be said that Wordsworth's vision has come true and that literary genius has found inspiring themes in the great achievements of modern science. John Davidson, however, in his "Testament" made some remarkable references to the structure of matter and the transition of substance to a condition of self-consciousness. But while so few of our masters of literature are responsive to results of scientific study, a rich field from which precious gems of thought could be derived is neglected. Among men of letters who have brought the human spirit into scientific themes in works of prose are Thomas Hardy, H. G. Wells, Sinclair Lewis and Aldous Huxley. Also, in the works of George Meredith, John Masefield, Laurence Housman and some other leaders, the fringe of such knowledge is occasionally the source of poetic expression. Fuller response to the growth of observational knowledge is found in Alfred Noyes, who, in the three volumes of "The Torch Bearers," has given us a stimulating epic of scientific discovery relating to the heavens, the earth and man's control of natural forces. There is no lack in this work of appreciation of the devotion of scientific pioneers to the cause of truth and their influence for good throughout the ages.

With such faithful and unrewarded investigators in mind, we recollect that Coleridge devoted one of his sonnets to Joseph Priestley, the discoverer of oxygen and pioneer in the experimental study of gases. Priestley's advanced views on theological and political subjects were so unpopular that in 1791 a mob fired his Unitarian chapel and sacked his house, causing him to seek safety in London. Three years later he emigrated to America, where he lived for ten years until his death. When Priestley left England, Coleridge was a young man of twenty-two and the sonnet was probably written at that time. It contains the lines:

> Though roused by that dark Visir riot rude
> Have driven our Priestley o'er the ocean swell;
> Though Superstition and her wolfish brood
> Bay his mild radiance, impotent and fell;
> Calm in his halls of Brightness he shall dwell;
>
> . . . . . .
>
> And from her dark retreat by wisdom won,
> Meek Nature slowly lifts her matron veil
> To smile with fondness on her gazing son!

It is not surprising that Priestley's departure from his native land should have aroused the sympathy of such a strong democrat as Coleridge. The cause of intellectual freedom has not, however, found a similar apostle among poets to-day when Einstein and hundreds of leaders in science, art and literature have been driven from the country of their adoption, in suffering and in shame, to find homes in other lands. If oppression and injustice can still stir the strings of the human heart, surely here is a theme for a poem which will live when the exiles who are now sorrowing by the waters of Babylon will have passed away.

This reference to Coleridge's tribute to Priestley, and the possible awakening of similar emotional response to-day, is, however, only incidental to the purpose of this address. There is no lack now of accurate description and graceful phrasing in poetic and other literature dealing with what may be called natural history subjects. It can not be said, however, that the intellectual horizon of men of letters generally has been extended by advances in modern science. There is not much evidence in the works of leaders in literature of assimilation of the new knowledge or even of the slightest sympathy with it. Occasionally, one finds a reasonable attitude towards the age of science and invention in which we live, but more usually there is an absence of an outlook which will regard science not merely as a storehouse of facts to be used for material purposes, but as one of the great human endowments to be ranked with art and religion, and the guide and expression of man's fearless quest for truth. "If we live in an age of mechanism," said "The Road-

mender of Michael Fairless, "let us see to it that we are a race of intelligent mechanics; and if man is to be the Demon of a machine let him know the setting of the knives, the rise of the piston, the part that each wheel and rod plays in the economy of the whole, the part that he himself plays, cooperating with it."

The machine has always been regarded as a soul-destroying agency, and one of the reactions is to escape from it and return to primitive conditions of life. This cult of romanticism has been the theme of many idylls in which the beauties of nature and the simple pleasures of country life are presented as ideal conditions of human existence. The machine itself is condemned instead of the selfish and unsocial uses made of its power. The greatness of scientific discovery and mechanical ingenuity is naturally overlooked because of sympathy for the working classes who have been exploited to secure industrial success and profits. The story of the development of the machine and its influence upon the cultural forms of western civilization is brilliantly told by Mr. Lewis Mumford in his work entitled "Technics and Civilisation," published last year. Here we have not merely an account of mechanical contrivances and the part they played in the industrial revolution, but a history of the machine and its social and esthetic influences over a period of a thousand years. The distinguishing characteristic of the volume is the attention given to mechanism as an element of human culture, how the perception of its meaning may be interpreted in painting and sculpture, so that art, and literature also, may be freed from the romantic prejudice against the machine as necessarily hostile to the world of feeling. Science and its effect upon invention and mechanization have created a new environment which can be shaped to satisfy man's intellectual as well as his material needs.

The sensitive apprehension of this new environment [says Mr. Mumford], its translation into terms which involve human affections and feelings, and that bring into play once more the full personality, became part of the mission of the artist; and the great spirits of the nineteenth century, who first fully greeted this altered environment, were not indifferent to it. Turner and Tennyson, Emily Dickinson and Thoreau, Whitman and Emerson, all saluted with admiration the locomotive, that symbol of the new order in Western Society. They were conscious of the fact that new instruments were changing the dimensions and to some extent, therefore, the very qualities of experience; these facts were just as clear to Thoreau as to Samuel Smiles; to Kipling as to H. G. Wells. The telegraph wire, the locomotive, the ocean steamship, the very shafts and pistons and switches that conveyed and canalised or controlled the new power, could awaken emotion as well as the harp and the war-horse; the hand at the throttle or the switch was no less regal than the hand that had once held a scepter.

How a machine in action can give the impression of rhythm, precision, efficiency and duty, working in harmonious unity, is strikingly illustrated in Mr. Rudyard Kipling's poem "M'Andrews' Hymn," in the course of which the chief engineer of a steamship replies to a passenger who has suggested that steam has spoiled the romance of the sea.

Romance! Those first class passengers they like it very well,
Printed and bound in little books; but why don't poets tell?
I'm sick of all their quirks and turns—the loves and doves they dream—
Lord, send a man like Robbie Burns to sing the Song of Steam!
To match wi' Scotia's noblest speech yon orchestra sublime
Whaurto—uplifted like the Just—the tail-rods mark the time.
The crank-throws gin the double bass, the feed pump sobs and heaves
An' now the main eccentrics start their quarrel on the sheaves!:
Her time, her own appointed time, the rocking link-head bides,
Till—hear the note?—the rod's return whings glimmerin' through the guides.
They're all awa'! True beat, full power, the clangin' chorus goes
Clear to the tunnel where they sit, my purrin' dynamoes.
Interdependence absolute, foreseen, ordained, decreed,
To work, ye'll note, at any tilt an' every rate of speed.
Fra skylight-lift to furnace bars, backed, bolted, braced an' stayed.
An' singing like the Morning Stars for joy that they are made;
While, out o' touch o' vanity, the sweating thrust-block says:
"Not unto us the praise, or man—not unto us the praise!"
Now, a'together, hear them lift their lesson—theirs an' mine:
"Law, Order, Duty and Restraint, Obedience, Discipline."—

That is the best illustration of what I understand by interpretation of mechanized science; and neither it nor any like it is usually to be found in anthologies of verse or prose. Among men of science themselves there are several who have passed from the laboratory into the garden of poetry and have successfully cultivated beautiful flowers in it, while others have shown themselves masters of English prose. Most scientific workers know well enough how science touches art and music, how it may enter into literature and how it makes history, but there is not like appreciation of its meaning from representatives of beauty and truth in other fields. It is to promote a closer relationship that this address has been written, so that knowledge

and the artist's response to it may be complementary to each other. William Watson expressed their spiritual unity in his verse

> Science and Art, compeers in glory,
> Boast each a haunt divine.
> "My place is in God's laboratory"
> "And in his garden, mine."

To the worker in the laboratory or observatory, however, it would be encouraging if the poet would occasionally stray into his domain and show interest in what is being done to understand structures and processes in nature. A few years ago, Mr. Kenneth Knight Hallowes undertook a detailed literary research with the view of finding what had been done to develop poetry of science since Wordsworth's forecast of its future, and he described his result in an essay published in a small book entitled "The Poetry of Geology," as well as in his complete "Poetical Works." A strong appeal is made in this essay for the creation of a new school of poets of science, who will employ their genius to interpret scientific truths with accuracy and charm.

Any such poetry must embody new conceptions and creative thought vibrant with human feeling and not be mere photographic images or phonographic records of phases of scientific knowledge. While it is to be regretted that achievements of modern science have failed to inspire contemporary poets, we realize fully that the human heart will not be touched by soulless descriptions of natural events or phenomena. "Poetry," said Leigh Hunt, "is the utterance of a passion for truth, beauty and power, embodying and illustrating its conceptions by imagination and fancy." There can be no inspiring poetry of science without the possession of these spiritual attributes and the artistic instinct which will clothe them in garments of blissful words and radiant phrases. When the poet of science does arise, he will probably not have had a specialized scientific training, but his mind will be sensitive to the wonder of scientific discoveries and the insight they afford into natural things from the atom to the celestial universe. Through appreciation of these revelations he will be uplifted to planes of creative thought and sublime interpretation.

SCIENTIFIC EVENTS

THE SECOND INTERNATIONAL CONGRESS FOR THE UNITY OF SCIENCE

THE second International Congress for the Unity of Science will take place in Copenhagen, from June 21 to 26. The central topic will be the relation of physics and biology (including psychology), with especial emphasis upon the concept of causality. A small number of invited speakers will provide the context for a general discussion. Professor Niels Bohr will participate in the congress.

Inquiries and notices of intended attendance at the congress may be directed to the secretary, Dr. Otto Neurath, Mundaneum Institute, 267 Obrechtstraat, The Hague, Netherlands. The subscription for active membership is a hundred francs.

The International Committee in charge of the annual congresses now consists of: M. Boll, Niels Bohr, P. W. Bridgman, Bonnet, Carnap, E. Cartan, J. Clay, M. R. Cohen, F. Enriques, P. Frank, M. Frechet, F. Gonseth, J. Hadamard, P. Langevin, Lashley, Lewis, Lukasiewicz, R. v. Mises, Morris, Neurath, Nicolle, C. K. Ogden, J. Perrin, Reichenbach, Abel Rey, Rist, Rougier, Bertrand Russell, Schlick, Stebbing, Woodger.

The *Proceedings* of the first congress, held at the Sorbonne in September, 1935, and devoted to the general topic of the logic or philosophy of science, are to appear in the early months of 1936 in the form of eight small volumes (Hermann and Co., Paris). A detailed report of the papers and discussions of the congress appears in volume 5, number 6, of the journal *Erkenntnis* (Felix Meiner, Leipzig). Plans are being made to hold one of the congresses in the United States within the next few years.

FELLOWSHIPS IN THE PHYSICAL AND BIOLOGICAL SCIENCES OF THE JOHN SIMON GUGGENHEIM MEMORIAL FOUNDATION

THE following appointments to John Simon Guggenheim Memorial fellowships for work in the physical and biological sciences are announced:

Dr. Harold Francis Blum, assistant professor of physiology, University of California: Appointed for the writing of a monograph on biological photosensitization: research in European laboratories and consultation with European authorities.

Dr. James Thomas Culbertson, instructor in bacteriology, College of Physicians and Surgeons, Columbia University: Appointed for studies of humoral and cellular immunological phenomena in the mechanism underlying the immunity against parasitic diseases, particularly the protozoan and helminthic infestations of man, chiefly at the London School of Hygiene and Tropical Medicine.

Dr. Solomon Gandz, New York City: Appointed for studies of early Arabic algebra, especially its connection with ancient Greek, Babylonian and Egyptian mathematics, and its influence upon medieval European mathematics.

Dr. George Whitfield Deluz Hamlett, research worker,

U. S. Biological Survey: Appointed for a study of the embryology and the reproductive cycles of various South American mammals.

Dr. Michael Heidelberger, associate professor of biological chemistry, Columbia University, and chemist to the Medical Service of the Presbyterian Hospital, New York City: Appointed for studies of the mechanism of immune reactions. (Renewal.)

Dr. Morris Moore, research fellow in mycology and dermatology, The Barnard Free Skin and Cancer Hospital, St. Louis, Mo.: Appointed for a comparative study of the life-cycles of certain disease-producing fungi of North and South America. (Renewal.)

Dr. Donald McLean Purdy, assistant professor of psychology, University of Maine: Appointed for a study of European functional psychology.

Dr. Marshall H. Stone, associate professor of mathematics, Harvard University: Appointed for research in mathematics, in particular in the field of the theory of linear representation in abstract space.

Dr. Lloyd Raymond Watson, professor of chemistry and director of research, Alfred University: Appointed for research toward the development of new and improved types of honey-bees.

Dr. George Willard Wheland, research fellow in chemistry, California Institute of Technology: Appointed for quantum mechanical investigation into the structure of organic molecules in collaboration with European authorities, and the gathering of material for a monograph on the same subject.

Dr. Perry William Wilson, assistant professor of bacteriology and chemistry, University of Wisconsin: Appointed for research into the problem of the fixation of nitrogen by bacteria, in consultation with European authorities.

THE ANNUAL CONFERENCE OF THE MILBANK MEMORIAL FUND

MORE than eighty leaders in public health, medicine and social work, connected with various federal, state, county and municipal services, educational institutions, voluntary agencies and other organizations, assembled on March 26 for the annual conference of the Milbank Memorial Fund at the New York Academy of Medicine. Dr. Livingston Farrand, president of Cornell University, a director of the foundation, presided.

The "next steps in public health" were discussed by one of the round-table groups. There was consideration of possible public activity in the prevention of cancer, pneumonia, diabetes, mental diseases, maternal and neonatal mortality, heart diseases and industrial hazards. This group was to have been presided over by Edgar Sydenstricker, scientific director of the fund, who died on March 19. Professor C.-E. A. Winslow, of the Yale University School of Medicine, took his place on the program. A round-table group under the chairmanship of Dr. George T. Palmer, deputy commissioner of health of the City of New York, discussed scientific methods of evaluating the effectiveness of specific health procedures and of measuring health services in relation to the needs of particular communities. A round-table on population studies was presided over by Professor Robert E. Chaddock, of Columbia University. On Friday afternoon the chairmen of these three groups presented reports of the discussions before the conference as a whole.

The Milbank Fund's annual dinner to its boards of counsel was given on the second evening. The speakers were: Albert G. Milbank, president of the foundation; Dr. Livingston Farrand, Professor C.-E. A. Winslow and Thomas I. Parkinson, president of the Equitable Life Assurance Society of the United States.

Others scheduled to take part in the two-day conference include: Reginald M. Atwater, secretary, American Public Health Association; E. L. Bishop, director of health, Tennessee Valley Authority; Henry D. Chadwick, Massachusetts State Commissioner of Public Health; Miss Dorothy Deming, R.N., general director, National Organization for Public Health Nursing; Louis I. Dublin, third vice-president of the Metropolitan Life Insurance Company; Kendall Emerson, managing director, National Tuberculosis Association; Charles E. Farr, president, Medical Society of the County of New York; Miss Elizabeth Fox, R.N., superintendent, Visiting Nurse Association, New Haven; John A. Hartwell, director, The New York Academy of Medicine; Charles J. Hatfield, executive director, Henry Phipps Institute, Philadelphia; Clarence Hincks, general director, National Committee for Mental Hygiene; J. H. Janney, Jr., health officer of Anne Arundel County, Maryland; Miss Katharine F. Lenroot, chief, United States Children's Bureau; H. S. Mustard, of the School of Hygiene and Public Health, the Johns Hopkins University; The Honorable Thomas Parran, Jr., Surgeon General of the United States Public Health Service; Raymond Pearl, professor of biology, the Johns Hopkins University; Eugene H. Pool, president, the New York Academy of Medicine; the Honorable John L. Rice, New York City Commissioner of Health; William F. Snow, general director, American Social Hygiene Association; Frederic E. Sondern, president, Medical Society of the State of New York; Raymond Squier, executive secretary, National Committee on Maternal Health; John S. Sundwall, director, division of hygiene and public health, University of Michigan; the Honorable Henry F. Vaughan, City Commissioner of Health, Detroit; P. K. Whelpton, Scripps Foundation for Research in Population Problems, Miami University, and John Wyckoff, dean, University and Bellevue Hospital Medical College.

THE ELECTROCHEMISTS AT CINCINNATI

THE sixty-ninth convention of the Electrochemical Society, an international scientific-technical organization, will be held at the Netherland Plaza Hotel, Cincinnati, on April 22 to 25. Over forty contributions will be presented from members from widely separated regions of the world: England, France, Austria, Germany, Spain, South Africa, besides the United States. The afternoons of Thursday and Friday will be devoted to factory visits.

"Electricity in Gases" is the topic of the Joseph W. Richards Memorial Lecture to be delivered on Thursday evening, April 23, by Dr. Karl K. Darrow, of the Bell Telephone Laboratories.

The annual banquet is scheduled for Friday evening, at which James H. Critchett, president of the society, will discourse on "The Metallurgy of Columbium," an essential constituent of modern stainless steels. Dr. Leo H. Baekeland, inventor of velox and bakelite, will be formally elected to honorary membership in the society, a distinction which only three others hold. The prize to young authors this year goes to U. B. Thomas, of the Bell Telephone Laboratories, for his improvements in storage battery performance.

Professor J. C. Warner, of the Carnegie Institute of Technology, Pittsburgh, will preside at the opening session on the morning of April 23. The topic of discussion will be "Inhibitors"—inhibitors added to acids to clean steel and prevent pits and perforations; inhibitors to retard rusting; inhibitors in rubber, paints and gasoline.

Dr. R. L. Seabury, of the General Motors Company, will be in charge of the session on Friday morning, April 24, at which batteries, dry cells and organic chemicals will be discussed. Jean Billiter, of Austria, will describe his method of converting the water of Lake Michigan into pure drinking water, and water equal in quality to distilled water, by a very simple electrochemical method.

Saturday morning will be devoted to "Electronics" and will be in charge of Dr. J. W. Marden, assistant director of the Westinghouse Lamp Company. Dr. M. Pirani, of the Osram Tungsten Lamp Factory, Berlin, will discuss the behavior of gases during electric discharge. Jos. Slepian, of the Westinghouse Company, will describe his new mercury arc power rectifier, a radical departure in design and steady performance. A. C. Hanson, of Washington, will show how x-rays pass through concrete walls.

The closing session on Saturday afternoon will be conducted by W. W. McCord, of the McCord Radiator Company, Detroit. A dozen papers will be presented on how to plate manganese on brass and steel; plating of aluminum alloys, and alloys of cobalt and nickel and of thallium and zinc. Professor B. S. Hopkins, of the University of Illinois, will discuss ytterbium; Professor Edgar Newbery, of South Africa, mercury perchlorate solutions, and there will be papers on antimony, copper, nickel, etc.

The fall meeting of the society will be held in Canada.

THE SUMMER MEETING OF THE AMERICAN ASSOCIATION

ROCHESTER, N. Y., the seat of the summer meeting of 1936, is perfecting plans for a series of events on Tuesday, Wednesday and Thursday, June 16, 17 and 18, which will appeal strongly to members of the association and others interested in science. A general invitation is extended to all such to participate in the various sessions.

The officers of the local committee are: Dr. H. L. Fairchild, honorary chairman; Dr. J. Edward Hoffmeister, chairman; Dr. W. R. Line, secretary; R. L. Thompson, treasurer. A larger and active general committee, subdivided into special subcommittees on program, publicity, meeting rooms and equipment, field trips, entertainment, etc., is working to provide for the needs of sections and societies.

The various sections are organizing programs and have appointed the following to act as secretaries for the Rochester meeting: Mathematics, Arthur S. Gale; Physics, T. Russell Wilkins; Chemistry, Walter R. Bloor; Astronomy, Samuel L. Boothroyd, Cornell University, Ithaca, N. Y.; Geology and Geography, Harold L. Alling; Zoological Sciences, Curt Stern; Botanical Sciences, William D. Merrell; Anthropology, W. M. Krogman, Western Reserve University, Cleveland, Ohio; Social and Economic Sciences, Donald W. Gilbert; Engineering, William J. Conley; Medical Sciences, Vincent du Vigneaud, George Washington University Medical School, Washington, D. C.; Education, Earl B. Taylor.

Titles of papers offered for presentation at the Rochester meeting may be sent to the appropriate representative, who, except as indicated, may be addressed at the University of Rochester.

For evening general sessions the association has been able to arrange on Tuesday evening an address by Dr. C. E. K. Mees, of the Eastman Kodak Company, on the subject "Color Photography." It will be illustrated with lantern slides and motion pictures in color. The Maiben Lecture will be given on Wednesday evening by Dr. Charles Camsell, Deputy Minister of Mines, Ottawa, Canada, on "A Four-thousand-mile Flight over Northwestern Canada in August, 1935." The material of this address is mainly geographical and is concerned with the northern termination of the Rocky Mountain system. The address is non-technical in character and contains some important observations of a cross-section of the Canadian Cordillera.

A reception in the corridors of the Eastman School of Music is to follow the lecture. On Thursday evening the address is by Dr. Carl Snyder, for many years statistician of the Federal Reserve Bank of New York and formerly president of the American Statistical Association, on the subject, "The Rôle of Capitalism in Civilization."

On Friday morning members will proceed by train or auto to Ithaca to join in celebrating the semi-centennial of Sigma Xi. All those in attendance at the Rochester meeting have been invited by Sigma Xi to participate in the Ithaca program, which will include addresses on Friday afternoon and Saturday morning as well as a complimentary dinner given to delegates and visitors by the Cornell Chapter on Friday evening. This will be followed by the semi-centennial address on "Scientific Research and Social Progress."

The hotel headquarters of the association will be at the Seneca. All hotels will cooperate with the association for the meeting. Members desiring accommodations will communicate directly with the hotels. The following rates will apply:

Seneca: Single, $3–$4.50; double, $3.50–$6; twin-beds, $4–$7. Rooms with running water: Single, $2.50; double, $3.50–$4.

Powers: Single, $2–$4; double, $3–$6; twin-beds, $6–$7. Rooms with running water: Single, $2; double, $3.

Rochester: Single, $2.50–$4; double, $4–$6; twin-beds, $5–$6.

Sagamore: Single, $3.50–$5; double, $5; twin-beds, $6–$7.

Hayward (especially desirable for parties coming "stag"): Single, $2–$3.50; double, $3.50–$6.

In addition to the hotel rooms listed above, there will be available a hundred rooms in the university dormitories on the River Campus for June 16, 17 and 18. These will be reserved for men only at $1.00 per day as long as the supply lasts. Requests for reservations for these dormitory rooms may be made to the General Superintendent of Buildings and Grounds, University of Rochester. To insure accommodations being held in the dormitories, a check for $3.00 (for three nights' occupancy) should accompany the reservation. This will be returned if notice to cancel is received on or before June 12.

Transportation from the city hotels to the campus is direct and will be easily effected. Railroad rates to Rochester can not be announced as yet, but some provision will be made and published notice given later. The regular preliminary announcement of the meetings with details will appear in SCIENCE early in May.

RECENT DEATHS AND MEMORIALS

DR. ARTHUR BALDWIN DUEL, of New York City, aural surgeon, chairman of the Board of Surgeons and vice-president of the Manhattan Eye, Ear and Throat Hospital, died on April 11 at the age of sixty-five years.

DR. JOHN URI LLOYD, of the Lloyd Brothers Pharmaceutical Company of Cincinnati, formerly president of the Cincinnati College of Pharmacy, died on April 9. He was eighty-six years old.

F. S. WILKINS, research assistant professor of agronomy at Iowa State College, died on March 31 at the age of forty-six years. Since his appointment to the staff at Iowa State College in 1915 he had been in charge of forage crops investigations. The results of his research have been published in a number of experiment station bulletins and journal articles.

DR. ROBERT BÁRÁNY, specialist in diseases of the ear and throat, Nobel laureate in medicine in 1914, died in Upsala, on April 8, at the age of sixty years.

MAURICE THÉODORE HAMY, since 1898 astronomer at the Paris Observatory, a member of the Paris Academy of Science, died on April 10. He was seventy-five years old.

A MEMORIAL service has been held in the great choir of the Washington Cathedral in honor of Dr. William H. Wilmer, formerly head of the Wilmer Institute of the Johns Hopkins Hospital.

A MEMORIAL meeting for Ivan Pavlov, the Russian physiologist, was held in the State Office Building, St. Paul, on April 7, under the auspices of labor leaders, Wahlfrid Engdall, Carpenters Local Union No. 7, presiding. The speakers were: The Man: Professor Rodney B. Harvey, plant physiology, University Farm, Minnesota. The Biologist: Professor Dwight E. Minnich, department of zoology, University of Minnesota. The Psychologist: Dr. John G. Rockwell, state commissioner of education. The Physiologist and Russian Medicine: Dr. Elias P. Lyon, dean of the Medical School, University of Minnesota. Biology and Economics: E. H. H. Holman.

SCIENTIFIC NOTES AND NEWS

DR. RUDOLPH MATAS, honorary chief of the surgical service at Touro Infirmary, was presented with a decoration and the title of commander of the National Cuban Order of Carlos Finlay and a diploma of honorary fellowship in the Academy of Medicine of Havana, at the recent annual meeting of the Southeastern Surgical Congress in New Orleans. The presentation was made by Dr. Charles Edward J. Finlay, Havana, Cuba, son of Dr. Carlos Finlay.

AT the meeting of the Society of Experimental Psy-

chologists at Clark University on April 9 and 10, the first award of the Howard Crosby Warren Medal was made jointly to Professor Ernest G. Wever and Dr. Charles W. Bray, of Princeton University, "for their studies of auditory nerve responses in reptiles and insects, following up their similar work on mammals, the whole research constituting an outstanding contribution to the study of auditory function." The medal was founded by Mrs. Warren in memory of her husband, Professor Howard Crosby Warren, the first chairman of the Society of Experimental Psychologists and for many years professor of psychology at Princeton University. The medal is to be awarded annually by the society "for outstanding work in experimental psychology in the United States or Canada published during the five years preceding the time of the award."

CHARLES CRAWFORD GORST was presented with the annual medal of the John Burroughs Association on the occasion of the celebration of his birthday which recently took place at the American Museum of Natural History. Dr. Clyde Fisher, curator of the Hayden Planetarium and of astronomy at the museum, presented the medal to Mr. Gorst with the explanation that the board of directors of the association had departed from tradition for the 1936 award in honoring Mr. Gorst "for the special recognition of his unusual art of interpreting bird songs." After an illustrated lecture in which Dr. Fisher recalled scenes from the life of Burroughs, Mr. Gorst spoke on birdlore and described his work.

THE Bessemer Gold Medal for 1936 of the British Iron and Steel Institute has been awarded to Fred Clements, director of the Park Gate Iron and Steel Company, Rotherham, in recognition of his distinguished services in improving the technology of the iron and steel industries and, in particular, blast-furnace practice.

PROFESSOR LEO FROBENIUS, director of the Research Institute for Cultural Morphology at Frankfort-on-Main, has been awarded the Bernhard-Hagen Medal by the Frankfort Society for Anthropology, Ethnology and Primeval History.

THE degree of LL.D. will be conferred by the University of Edinburgh on Sir Thomas Hudson Beare, regius professor of engineering and dean of the Faculty of Science in the university; on Dr. Mervyn Henry Gordon, consulting bacteriologist; on Sir Willian McKechnie, permanent secretary, Scottish Educational Department; and, as previously announced, on Professor E. L. Thorndike, of Teachers College, Columbia University.

DR. ISAIAH BOWMAN, president of the Johns Hopkins University, and thirty students were initiated into the Johns Hopkins Chapter of the Phi Beta Kappa Society on April 17. Initiation ceremonies followed a dinner, at which Dr. Bowman spoke. Officers of the chapter are: Dr. J. B. Whitehead, professor of applied engineering and dean of the faculty of engineering, *president;* Dr. Lewis H. Weed, professor of anatomy and director of the school of medicine, *vice-president;* Dr. Hazelton Spencer, *secretary,* and Dr. A. E. Blumberg, *treasurer.*

DR. LEONARD CARMICHAEL, professor of psychology and director of the psychological laboratory at Brown University, has been appointed dean of the college and head of the department of psychology at the University of Rochester. Dr. Carmichael will be succeeded at Brown University by Dr. Walter Samuel Hunter, G. Stanley Hall professor of genetic psychology at Clark University. Dr. Raymond Royce Willoughby, of Clark University, will accompany Dr. Hunter to Brown University as research associate in psychology, and Dr. Edward Harris Kemp, of Harvard University, has been appointed instructor.

JOHN M. LESSELLS, consulting mechanical engineer, of Swarthmore, Pa., editor of *The Journal of Applied Mechanics,* has been appointed associate professor of mechanical engineering at the Massachusetts Institute of Technology.

DR. FRANK FREMONT-SMITH resigned on February 1 as assistant professor of neuropathology at the Harvard Medical School.

DR. J. S. BAXTER, assistant professor of anatomy and acting head of the department at McGill University since 1934, will leave next month for England, where he will join the staff of the University of Cambridge. Dr. Baxter will take several months' holiday before taking up his new work.

THE Post-Graduate Medical Institute at Leningrad has created a chair for the pathology and physiology of nervous activity, under the direction of K. Petrova, a pupil and collaborator of the late Professor Pavlov.

DR. EDWARD S. GODFREY, JR., New York State assistant commissioner of health, was nominated by Governor Herbert H. Lehman on April 6 as state commissioner of health, to succeed Dr. Thomas Parran, Jr., who resigned to become surgeon general of the United States. The nomination was sent to the Senate for confirmation and has been referred to the Finance Committee. Dr. Godfrey was appointed a sanitary supervisor of the department in July, 1917, by Dr. Hermann M. Biggs, then commissioner of health. He subsequently served as epidemiologist and later until 1931 as director of the division of communicable diseases.

DR. MAURICE C. HALL, chief of the Zoological Divi-

sion of the Bureau of Animal Industry of the U. S. Department of Agriculture, and three associates have been transferred to the National Health Service. Dr. Hall will become chief of the Division of Zoology. Those who accompany him to his new work are Dr. Eloise B. Cram, Dr. Myrna Jones and Dr. John Bozicevich. Dr. Benjamin Schwartz, formerly assistant chief of the Zoological Division in the Bureau of Animal Industry, is now acting in charge.

JAMES MOFFITT, of San Francisco, has been appointed curator of ornithology and mammalogy in the Museum of the California Academy of Sciences to fill the position left vacant through the recent death of Harry S. Swarth.

DR. CRANFORD HUTCHINSON and Dr. Edward McCrady, Jr., fellows of the Wistar Institute, Philadelphia, have been advanced to the rank of associates of the institute.

DR. ROBERT B. GORDON, of the department of botany of the Ohio State University, has been made director of the Allegany School of Natural History, which will hold its tenth session from July 5 to August 22. Conducted by the Buffalo Society of Natural Sciences, in cooperation with the New York State Museum and in affiliation with the University of Buffalo, the school provides seven-week field courses with college credit in the University of Buffalo.

DR. S. C. WHITLOCK, assistant professor of veterinary anatomy of the Iowa State College, has resigned to accept a position as veterinarian with the Michigan State Board of Wild Life Conservation.

JAMES W. BURCH, assistant director in charge of the extension service of the Missouri College of Agriculture, and four Missouri farmers have been appointed by Mr. Wallace, Secretary of Agriculture, members of a state board that will pass on soil conserving crop diversions and set standards for soil-building practices in Missouri under the new farm program.

PROFESSOR FRANK B. HOWE, who has had leave of absence from Cornell University, has resigned as coordinator of the Federal Soil Conservation Service in New York State, and has returned to the university.

DR. ALEŠ HRDLIČKA, curator of physical anthropology at the Smithsonian Institution, will leave Seattle, Wash., on May 16 for his fifth summer of research into the past of the American Indian on Kodiak Island, off the Alaskan coast.

C. JUDSON HERRICK, emeritus professor of neurology at the University of Chicago, will deliver the fourteenth Pasteur lecture of the Institute of Medicine of Chicago on Friday evening, April 24, at Northwestern University. His subject will be "Neurobiological Foundations of Modern Humanism."

DR. HANS ZINSSER, professor of bacteriology at the Harvard Medical School, spoke on April 3 before Tulane University Chapter of Sigma Xi. The lecture was entitled "Studies on Immunity in Relation to Filterable Viruses."

THE GEHRMANN lectures of the College of Medicine of the University of Illinois for 1935–1936 will be delivered on April 29, 30 and May 1, by Dr. Victor G. Heiser, formerly director for the Far East of the International Health Board of the Rockefeller Foundation. The titles of the lectures are: "Coordination of Disease Control throughout the World by the League of Nations"; "International Research in Leprosy"; and "Dietary Opportunities in Preventive Surgery."

PROFESSOR R. HÖBER, in collaboration with Professors M. H. Jacobs and L. V. Heilbrunn, together with representatives from the departments of botany, biophysics, physics, chemistry, pathology, bacteriology and experimental medicine, will give a course in advanced general physiology at the University of Pennsylvania next year. Professor Höber was formerly head of the department of physics and rector of the University of Kiel. He is the author of "Die physikalische Chemie der Zelle und Gewebe," now in its sixth edition.

CURATOR FRANK E. LUTZ, Dr. W. J. Gertsch and Wm. C. Wood, of the American Museum of Natural History, spent February and March in field work on the butterflies and moths of Panama. Two regions were selected in which to do intensive collecting. One was Barro Colorado, the large island in Gatun Lake, Canal Zone. It is almost entirely covered by a rather dense jungle typical of the low hills near sea-level in Central America and is the laboratory of the Institute for Research in Tropical America. The other was on the western slope of the Volcano (extinct) of Chiriqui near the Costa Rican border. Headquarters there were at an altitude of about 4,200 feet. In addition to the high-altitude jungle, this region has a large area of naturally open country. It furnished a good contrast with Barro Colorado. The faunas of the two regions differ markedly, a condition which not only resulted in the expedition's getting a large range of species for the museum's collection but also will, it is hoped, help in understanding the geographic distribution of insects in Central America.

THE installation of the sixty-eighth chapter of the Society of Sigma Xi at the University of Buffalo will be held on April 25. Among those to appear on the installation programs are: Professor William F. Durand, of Stanford University; Professor Edward Ellery, of Union College, and Dean F. K. Richtmyer, of the Graduate School of Cornell University. The

formal installation ceremonies include presentation of the charter to the new chapter, initiation of new members, election of officers and adoption of a constitution. Professor Durand, who is president of the national society, and Professor Ellery, secretary, will be the installing officers. Dr. Durand will deliver the charge to the new chapter, and the response will be made by Professor Gehman, president of the old Sigma Xi Club. Following the installation ceremonies the installation banquet will be held. The speakers will be Chancellor Samuel P. Capen, Professor Durand and Professor Ellery. Delegates from other chapters and other universities will be present. The Sigma Xi Lecture will be delivered in the evening by Professor F. K. Richtmyer, whose topic will be, "Science in the Service of Society."

THE seventeenth annual meeting of the American Geophysical Union, established to promote the study of problems concerned with the figure and physics of the earth; to initiate and coordinate researches which depend upon international and national cooperation, and to provide for their scientific discussion and publication, will meet on April 30 and May 1 and 2, in the buildings of the National Academy and Research Council, the U. S. Geological Survey and Georgetown University.

THE New York Geographical Association will hold its second annual meeting at Syracuse University on May 2. Professor Griffith Taylor, of Toronto, and Professor Stanley Dodge, of Michigan, will be the guest speakers.

THE Field Conference of Pennsylvania Geologists and the New York State Geological Association will hold a joint excursion in the Pennsylvania anthracite region from May 22 to 24. The party will assemble in Scranton on Friday morning. The afternoon will be spent in the Northern Field. The Middle Field between Wilkes-Barre and Pottsville will be visited Saturday. The party will study the Southern Field on Sunday. Friday night will be spent in Wilkes Barre and Saturday night in Pottsville. Any geologist intending to join the party is requested to notify the secretary, Dr. Lawrence Whitcomb, Lehigh University, Bethlehem, Pa.

AT a recent meeting of the Josiah Macy, Jr., Foundation, its treasurer, Robert E. Allen, vice-president of the Central Hanover Bank and Trust Company, announced the receipt of an additional gift of $200,000 from Mrs. Kate Macy Ladd, who established the foundation in 1930 in memory of her father. It was reported also that since its establishment the foundation had distributed approximately $700,000 for grants in aid. These grants have been primarily for basic research in medicine and allied fields. The recent gift will be used for the support of activities in progress under subvention of the foundation.

DISCUSSION

BEQUEST OF PAVLOV TO THE ACADEMIC YOUTH OF HIS COUNTRY[1]

WHAT can I wish to the youth of my country who devote themselves to science?

Firstly, gradualness. About this most important condition of fruitful scientific work I never can speak without emotion. Gradualness, gradualness and gradualness. From the very beginning of your work, school yourselves to severe gradualness in the accumulation of knowledge.

Learn the ABC of science before you try to ascend to its summit. Never begin the subsequent without mastering the preceding. Never attempt to screen an insufficiency of knowledge even by the most audacious surmise and hypothesis. Howsoever this soap-bubble will rejoice your eyes by its play it inevitably will burst and you will have nothing except shame.

School yourselves to demureness and patience. Learn to inure yourselves to drudgery in science. Learn, compare, collect the facts!

Perfect as is the wing of a bird, it never could raise the bird up without resting on air. Facts are the air of a scientist. Without them you never can fly. Without them your "theories" are vain efforts.

But learning, experimenting, observing, try not to stay on the surface of the facts. Do not become the archivists of facts. Try to penetrate to the secret of their occurrence, persistently search for the laws which govern them.

Secondly, modesty. Never think that you already know all. However highly you are appraised, always have the courage to say of yourself—I am ignorant.

Do not allow haughtiness to take you in possession. Due to that you will be obstinate where it is necessary to agree, you will refuse useful advice and friendly help, you will lose the standard of objectiveness.

Thirdly, passion. Remember that science demands from a man all his life. If you had two lives that would be not enough for you. Be passionate in your work and your searchings.

[1] Written just before Pavlov's death, at the age of eighty-seven years, on February 27, 1936. Translated from the Russian by Professor P. Kupalov, chief assistant in the Pavlov Institute at Leningrad.

INVESTMENTS IN SCIENCE AND SCIENTIFIC PUBLICATIONS

DONATIONS for the advancement of science may properly be considered as investments and hence to be guided by the practice which sound business experience has established to safeguard both principal and interest. To be justified in receiving benefactions, a scientific organization should satisfy the following requirements: (1) The funds made available should render a service of distinct value. (2) Evidence should be at hand that the funds will be administered economically. These two requirements may be summed up by saying that an investment in the way of donations for the advancement of science should be subjected to as careful checks, both by the recipient and by the donor, as would be a financial investment in order to ensure a profitable yield in the way of scientific dividends. (3) There should be as adequate and permanent recognition of the service rendered as is given to memorial buildings or to signed articles which embody the discoveries in science.

Let us see how these principles might be applied to an investment in the publication of a scientific society devoted, let us say, to biological interests. (1) An outstanding need in science is an increase in the facilities for making known the results of research, a need which appears less well recognized outside of active investigators than the need for buildings and salaries. (2) Let us assume that our biological journal under discussion had a wide circulation so that its contributions were readily available to biologists throughout the scientific world. Let us assume further that it could be shown that the journal was managed economically and that its editorial policies were such that the articles published were of high quality. (3) The third requirement of recognition to the donor might be met by a statement on the cover of the journal regarding those who had subscribed to certain units which might read somewhat as follows: "The publication of this journal has been aided in part by the income from the John Doe Fund." This statement might or might not be accompanied by a medallion such as appears on the title page of all publications of the Carnegie Institution of Washington and of some other organizations. Such a statement would be an enduring recognition of a continuing service. Units might be established at $25,000 each which at four per cent. should yield $1,000 or, in terms of publication, a total of upwards of 200 additional pages of the usual format. Units of less amount might not be desirable since the number of units would probably be limited. A unit would bear the donor's name beginning with the subscription, or it might remain anonymous during his life time. Arrangements for a unit could also be made in one's will. A unit would be a fitting investment of a fund in memory of one whom a number of contributors wished to unite in honoring.

Among the specific needs which are likely to be felt by a scientific society such as we are discussing may be mentioned the following: (1) Facilities for publishing more papers. (2) Better illustrations. (3) A monograph series for important papers of greater length than can be handled in its journal. (4) Payment of some salary to the editor-in-chief as is done for a certain few other journals. The editor's work is probably entirely voluntary and a society can not keep a good editor for long periods on this basis, especially if his labors were to be increased by an enlargement in the size of the journal made possible by an endowment.

The desire to have one's name perpetuated in after life in some material way is a normal characteristic of the human mind and is to be commended. The builders of the pyramids expressed this desire in huge piles of stones which endure to this day as gigantic tombstones in the desert. The modern world is more practical. It desires its memorials to have a large element of service. Science can be of help to those seeking a substitute for tombstones and memorial buildings by offering opportunities for enduring recognition of service rendered and by insisting that benefactions received shall be considered as investments with high dividend yields in service to science.

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DEPARTMENT OF GENETICS,
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PUBLICATIONS OF THE U. S. NATIONAL MUSEUM

I HAVE recently received the report of the U. S. National Museum for 1935. In it, I read (page 2):

> The only slightly increased allotment for printing and binding was little beyond the amounts absolutely required for the annual report and for blanks, forms, labels and similar routine printing. Researches on the extensive collections of the museum form important contributions to all branches of science and are of wide application in the progress and welfare of our country. At present while our research work progresses steadily, only a very small fraction of the new information gained can be issued because of lack of funds for printing. The result is a definite public loss. And again (p. 13) On account of the greatly reduced allotments for printing for the museum, the publications output of the editorial office was small. Only eight publications [all small, none of 100 pages, except the Annual Report] were issued during the year.

It seems incredible that the U. S. Government, certainly not averse to large expenditures, should feel

unable to furnish the relatively small amount necessary to render fruitful the work of the museum. One consequence is that the research work does not go on as it should, and in particular those specialists who would gladly cooperate with the museum have to turn elsewhere, often to foreign institutions, as I could readily explain in detail. There is, underlying these matters, a not unnatural difference of opinion. Most of the output of the museum ministers to the cultural side of life, to the advancement of knowledge, without obvious immediate economic significance. The ultimate economic significance of such knowledge can be urged with every reason, but this does not interest the man whose needs are pressing at the present moment. Much of the work, however, has a cultural purpose, giving real value to those who can utilize it but barren to those who can not.

Recently I took part in a symposium on adult education, held in Denver. I ventured to urge the publication of a series of small books, designed to interest the public in the natural history and physical features of the state. Directly I sat down, I was confronted by a prominent trades union representative, who exclaimed, with some show of emotion, that all those things were useless, if a man did not have a job. I could understand his point of view, but it seems to me that we must continually urge the importance of the cultural side of life, without which the economic security we all desire will prove a qualified blessing.

T. D. A. COCKERELL

THE FALL OF BROWN SNOW IN NEW HAMPSHIRE

DURING the early morning of February 25, 1936, about 2 cm of sleet and hail fell at Hillsboro, N. H., following about 10 cm of light snow the evening before. The hail had a distinctly brownish, purple color, and contrasted strongly with the pure white new snow beneath when the crust was broken. Close examination revealed that the color was due to minute particles of soil. The day before newspapers had reported severe dust storms in Colorado and other parts of the West. Connection between the two occurrences seems generally accepted. In order to determine the amount of silt deposited, 3 samples 1 sq. m. in area were laid out on level ground about 100 m. apart, and away from trees or buildings near Hillsboro, N. H., alt. 800′. All the snow and hail showing discoloration was removed from the sample areas with a clean plate and placed in clean enameled kettles. When melted the resulting water was distinctly dirty and some sediment quickly settled out. Dark purple, oily bubbles were common on the surface. After standing one week in a large graduate the suspension had cleared partially, but the purplish film persisted on the surface. The water from the meter-square samples was evaporated by boiling and the sediment collected in a Gooch crucible in sample I and in weighed filter papers in II and III after it had proven extremely slow work to get water to pass through the soil collected in crucibles. The samples were then oven-dried, cooled in a desiccator and weighed. The results were as follows:

	Wt. of silt deposited on 1 sq. m.
Sample I	1.6192 grams
Sample II	1.1600 grams
Sample III	1.6682 grams
Av.	1.3825 grams

This is at the rate of 1,382 kg. per sq. km. and roughly equivalent to 12.3 lbs. per acre or almost 4 tons per sq. mile.

HENRY I. BALDWIN

HILLSBORO, N. H.

THE OSBORN LIBRARY OF VERTEBRATE PALEONTOLOGY

AMONG other interests the late Professor Henry Fairfield Osborn was deeply concerned with the problem of making the literature of vertebrate paleontology accessible to workers, not only through bibliographies in which he strongly believed, but by collecting the actual volumes and separata in one departmental library. To that end he established the Osborn Library of Vertebrate Paleontology in 1908, presenting his personal library as a nucleus. To this the American Museum of Natural History added such volumes as it already possessed, its very excellent file of paleontological periodicals which it has kept up to date, and continued purchasing such new volumes as its funds made possible.

As in any departmental library, however, the separata are the greatest needs of the worker, Professor Osborn continued to turn over to the Osborn Library files of those papers which he received from his colleagues. Among the minor results of his death is the fear that this library which he founded will have its usefulness diminished because comparatively few of those actively engaged in paleontological publication realize that securing author's separata is an almost impossible task without the author's cooperation.

It is earnestly urged that those who have exchanged papers with Professor Osborn during his life will continue to keep the Osborn Library on their lists. It will be at once a tribute to Professor Osborn's memory and a service to fellow-workers since the Osborn Library is open to all. To those who are newcomers in the field it may be said that the gift of their papers will be a courtesy which will be deeply appreciated.

BARNUM BROWN

SPECIAL CORRESPONDENCE

THE SOCIETY FOR THE PROTECTION OF SCIENCE AND LEARNING

THE Academic Assistance Council was formed in May, 1933, to assist scholars and scientists who, on grounds of religion, race or opinion, were unable to continue their work in their own country. Its services have been needed chiefly to help the 1,300 university teachers displaced in Germany, but it has also assisted refugee scholars from Russia, Portugal and other countries.

In cooperation with other organizations, the council has assisted in permanently re-establishing 363 of the 700 displaced scholars who left Germany. A further 324 are still being temporarily maintained in universities and learned institutions while seeking more permanent positions. The council has directly received over £46,000 in donations which, with the exception of the small amount used for paying fares of displaced scholars to positions overseas, administrative expenses and other incidental purposes, have been employed in subsidizing research by our refugee guests. The council, as the international center for this work, has built up a place-finding organization and information service which are proving of increasing usefulness.

The council hoped that its work might be required for only a temporary period, but is now convinced that there is need for a permanent body to assist scholars who are victims of political and religious persecutions. The devastation of the German universities still continues; not only university teachers of Jewish descent, but many others who are regarded as "politically unreliable" are being prevented from making their contribution to the common cause of scholarship.

The council has decided to establish as its permanent successor a Society for the Protection of Science and Learning, which will continue the council's various forms of assistance to scholars of any country who, on grounds of religion, race or opinion, are unable to carry on the scientific work for which they are qualified. One function of the society will be to build up an Academic Assistance Fund to award research fellowships, tenable in the universities of Great Britain and other countries by the most distinguished of the refugee scholars.

This fund will be administered under the auspices of His Grace the Archbishop of Canterbury, the president of the Royal Society, the president of the British Academy, Lord Horder, the Hon. R. H. Brand and myself.

I appeal confidently and urgently to all those who wish to assist in the defence of free learning and science to join the society by paying a minimum annual subscription of one guinea. I hope that many will make a larger donation either to the society or to the fund, or will undertake to covenant with the society for a seven-year contribution, thus allowing us to recover income tax on the donations. Gifts to the fund may be earmarked if desired for the establishment of particular fellowships or studentships bearing the name of the donor.

This appeal is made with the full cooperation of the organizers of the National Christian Appeal which is about to be made for the destitute non-Jewish refugees from Germany, since the society will be giving assistance to only one section, namely the scholars, among the German refugees, irrespective of their religious affiliations. It is therefore with confidence that I ask support from both the Christian and the Jewish world, and in particular from the university world, to place this most important part of the refugee work on a firm financial basis.

Contributions and subscriptions should be sent to me at the offices of the Academic Assistance Council, 12 Clement's Inn Passage, Clare Market, W.C.2, made payable to the "Academic Assistance Council."

RUTHERFORD,
RUTHERFORD OF NELSON,
President of the Academic Assistance Council.

THE FREEDOM OF LEARNING[1]

Sir,—In your issue of March 18 you published an account of the new plans of the Academic Assistance Council for the reorganization of its work and the creation of a permanent body—the Society for the Protection of Science and Learning—with the general aim of safeguarding the freedom of learning. The undersigned, and with them their friends, collaborators and pupils, feel that they should not let this moment go by without publicly expressing their gratitude to the Academic Assistance Council, as the executor of the good will and friendship of their English friends.

Hundreds of scholars, faced with the necessity of abandoning their studies, have sought and found advice and help from this organization. It is due to the devotion and energy of the members of the council that difficulties which at first appeared insurmountable have been overcome, and that the council, in collaboration with other organizations, has succeeded in placing 363 out of 700 displaced scholars. In reality, far more has been achieved than these numbers indicate. It is in the very nature of the problem that even where no material assistance was possible, help could be given by satisfying spiritual needs. The warm sympathy extended to all who approached the Academic Assistance Council has helped in hundreds of cases—this part of its work can not be illustrated in figures.

[1] Letter addressed to the editor of the London *Times*.

The Academic Assistance Council is coming to an end in its emergency form, but we and our friends will endeavor to make it remain unforgotten. May we hope that the continuation of our scientific work—helped in no small measure by its activities—will be an expression of our gratitude?

ALBERT EINSTEIN
E. SCHRÖDINGER
V. TCHERNAVIN

SCIENTIFIC BOOKS

GENETICS TEXTS

The Principles of Heredity. By LAURENCE H. SNYDER, Sc.D. D. C. Heath and Company. 1935. xiii + 385 pp. $3.00.

Principles of Genetics and Eugenics. A Study of Heredity and Variation in Plants, Animals, and Man. By NATHAN FASTEN, Ph.D. Ginn and Company, New York. 1935. $2.80.

WITH the development of the science of genetics there has been a tendency on the part of writers of text-books on the subject to retain all the old and include all the new. Snyder's "Principles of Heredity" certainly covers a lot of territory for an elementary and presumably one-semester course, but the material is presented in such a logical, clear and scholarly manner that a competent teacher should be able to go far with it. A student attempting to master it alone would doubtless have difficulties, but it is obviously not intended to be so used. The problems given at the ends of the chapters are well chosen and together with the selected references will be very helpful to the discriminating teacher.

The material is frankly presented with a human bias; but although, as the author says, "human characters have been used wherever feasible as the source of data," other material constitutes a goodly portion of the book, and there are even special chapters on "The Genetics of Domestic Animals" (12 pages) and "The Genetics of Cultivated Plants" (18 pages). It is really remarkable how much is covered in this space. The condensation of the physiology of reproduction of different phyla of plants into less than ten pages (including illustrations) is really a feat, but the student will doubtless need either previous knowledge or adequate help in order to master it.

The general plan of the book does not depart greatly from the conventional. After presenting simple (monohybrid) Mendelian inheritance, there is a chapter on the physical background (cytology), after which dihybrid and modified ratios, sex-linkage, lethals, multiple allelomorphs, etc., are taken up in much their usual order. The human interest is concentrated in the last four chapters, which deal respectively with the inheritance of physical and physiological traits in man, of mental traits in man, eugenics and the analysis of human family histories. The last will probably seem rather special for a general text, but may prove useful for those students especially interested in human inheritance. The author states in the preface that "it is the frank purpose of the book to arouse and hold the interest of the student and to stimulate his thoughts along lines of genetic principles and their consequences." With proper instructional guidance it seems admirably adapted to the purpose.

The book is clearly printed with a refreshing number of new illustrations. It is remarkably free of both factual and typographical errors. There is no glossary, but an adequate index.

Fasten's "Principles of Genetics and Eugenics" is avowedly "an elementary text for students who desire accurate knowledge and up-to-date information in genetics and eugenics," but is apparently intended to make somewhat of a popular appeal. While it is presumably sufficiently up-to-date for elementary purposes (although in the discussion of the nature and location of genes there is no mention of the evidence from salivary chromosomes), there is an unfortunate number of cases in which the facts are inaccurate or give the impression of being so from the way in which they are stated. Thus in describing Mendel's experiments with tall and short pea plants (p. 171), to state that the tall plants, "when mated together," gave only tall scarcely conveys the idea of self-pollination, which is the only practicable method of making the test. Again, even Mendel with all his industry and patience would have found it a too tedious process to test the genotype of tall individuals by the use of a *back cross,* as stated on page 173. And on the next page it is stated that Mendel also studied the cross of peas with "seed coats yellow and seed coats green"; if such were the case Mendel would have had difficulty in explaining the segregation in the seeds on the F_1 plant. The various eye colors in man are attributed to different degrees of brown and *blue* pigment, which would seem to be merely a slip were it not repeated a page or so later. And without intending to be captious, one suspects that Davenport was rather more than "of the opinion" that the height of the individual is determined by the length of the component parts of the body!

In spite of these defects, however, the text presents a wide range of interesting material. Much emphasis is placed on eugenics, and while this part leans a bit towards propaganda, the author is on the whole conservative in his recommendations.

The extensive glossary appears to have been prepared with considerable care and the text is well indexed.

L. J. C.

SPECIAL ARTICLES

FUNCTIONAL ACTIVITY OF THE MAMMARY GLAND IN RELATION TO EXTRA-CHROMOSOMAL INFLUENCE IN THE INCIDENCE OF MAMMARY TUMORS

IN the experiments reported by Little[1] and Murray and Little[2,3] reciprocal crosses were made between "low-tumor" and "high-tumor" strains of mice. The F_1 generation produced by "high-tumor" females × "low-tumor" males gave mammary tumors in 39.82 per cent. of 113 virgin females that lived to reach "cancer age." Similarly, the reciprocal F_1 generation derived from "low-tumor" females × "high-tumor" males gave only 6.06 per cent. mammary tumors in 379 virgin females. The authors concluded that the incidence of mammary tumors in mice depends primarily upon the direct transmission of extra-chromosomal influences and that in the cross where the mother was derived from the "low-tumor" strain an "extra-chromosomal influence non-mammary tumor" was associated with a low percentage of spontaneous mammary tumors in the F_1 virgin females that reached the "cancer age." This general conclusion was consistent with results from back-cross and F_2 matings.

The writer has studied the effects of functional activity of the mammary gland on the incidence of spontaneous mammary tumors in various strains of mice and two strains were kindly supplied by Dr. Little's laboratory. Crosses were made between two "low-tumor" strains, one the C57 black, which was the "low-tumor" strain used by Murray and Little in the experiment described above, and another closely inbred "low-tumor" strain CBA.

The following results are based on nine sets of crosses, in each of which the female parent was derived from the C57 "low-tumor" strain. The male parent was derived from the CBA "low-tumor" strain.

According to Murray and Little the F_1 females from this cross, if kept virgin, would be expected to show only a small percentage of mammary tumors. The following results show that when such F_1 females are bred rapidly and not allowed to nurse their young they develop adenocarcinoma of the mammary gland at a relatively early age and in 100 per cent. of the nine experiments herein recorded. The tumors may be of multiple origin and one metastasized to the lung.

The results are shown in Table I. Nine females were tested. They averaged 93 days of age when their first litters were born. The average number of litters per female was approximately eight, the average number of days between litters 25, the average number of young per litter 7.3 and the average age of the females at which the tumors were first noted was approximately nine months. In each of four females three spontaneous tumors were noted, one female had two tumors and in four there were solitary growths. Histological data were obtained for all but one female, No. 294. Two tumors, one in the right axilla and one in the left inguinal region in this animal, were typical of the series, but on the death of the female the body was destroyed by cage mates.

TABLE I

Female No.	Age at first litter in days	No. litters	Ave. No. days between litters	Av. No. of young per litter	Age of female when tumor first noted	Hist. diag. mammary tumor	No. spont. mammary gland tumors
293	118	7	28	8.0	268	Adenocarcinoma	3
294	118	10	27	5.5	383	Adenocarcinoma?*	2
318	72	11	26	7.3	397	Adenocarcinoma	1
319	58	10	22	7.9	239	"	1
320	63	8	29	7.1	244	"	1
380	93	7	27	7.9	254	(Lung metast.)	3
381	101	5	22	6.0	182	Adenocarcinoma	3
382	104	6	26	8.3	258	"	3
383	111	7	23	8.0	230	"	1
	Av. = 93	Av. = 7.9	Av. = 25	Av. = 7.3	Av. = 274		Av. = 2

* See text.

These results are not necessarily incompatible with those of Murray and Little. They show, however, that the threshold for tumor incidence can be lowered by intensifying the functional activity of the glands. The procedure subjected the mammary glands to abnormal ovarian stimulation, they were unable to reach a normal resting condition and the lack of drainage of retained secretions may have in turn resulted in chemical irritation of the glandular epithelium. Rapid breeding was made possible by providing an adequate high protein diet. A further item of interest is that all the females in the F_1 generation produced mammary tumors and yet their parents were derived from "low-" or "non-tumor" strains. If both strains are free from cancer then one would not expect to find neoplasms in 100 per cent. of their F_1 daughters, unless more than one factor difference is involved and then the results would have to be explained on the basis of the action of complementary factors.

It is possible that the parent stocks I used were not entirely free from mammary gland cancer. This has since been further indicated by reports from Dr.

[1] Little, SCIENCE, 79: 465, 1933.
[2] Murray and Little, SCIENCE, 82: 228, 1935.
[3] Murray and Little, *Genetics*, 20: 466, 1935.

Little's laboratory (personal communication) showing the occurrence of 13 recently discovered spontaneous mammary gland tumors in females of the CBA line. The "functional test" that I have described above when applied to the C57 black "low-tumor" strain has already resulted in locating four females with mammary carcinoma. Twenty-one C57 females were included in this group. Five died when under 5 months of age, seven under 10 months and one at 13 months. One is alive at 10 months and three at 4 months of age. None of these showed tumor growth. The four females showed the first evidence of a mammary gland tumor when 6½, 8, 10 and 11 months of age, respectively.

In addition another female from "low-tumor" strain CBA developed a spontaneous mammary gland tumor when 13 months of age. This animal was from a group of 17 females and the only one to show a spontaneous growth. Of the remaining animals, twelve died when under 10 months of age, two at 13 months, one at 17 months and one at 18 months of age.

Conclusion: Increased functional activity of the mammary glands, under the conditions of the experiment described above, has resulted in masking any such reaction as an "extra-chromosomal influence" on the incidence of mammary tumors in mice as reported by Murray and Little. The results show that female mice, with hybrid vigor, whose mothers are derived from a strain relatively free from spontaneous mammary adenocarcinoma, have the capacity of producing such growths spontaneously, at a relatively early age, and in a high percentage of the females so far studied. The results are preliminary and are now being tested on a larger series of animals and using the exact crosses which Murray and Little have reported on.

HALSEY J. BAGG

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DELAYED KILLING OF MAIZE SEEDLINGS WITH X-RAYS

IN the course of experiments with x-ray treatments of dry seeds of maize and related species, a range of dosages has been found which causes all the plants to die in the seedling stage without reducing the percentage of germination. This phenomenon has been termed "delayed killing." In the published accounts of lethal x-ray dosages applied to dry seeds little significance has been attached to the fact that seedlings may make growth before they die. A study of the seedlings that have lost—by previous x-raying of the seeds—something essential to their continued existence should throw light on the nature of the biological changes brought about by the x-rays.

Seeds of dent corn were exposed to a source of x-rays obtained from a Coolidge x-ray tube with tungsten anode operating under a constant potential of 48 kv. This provided a continuous band of radiation with maximum intensity at approximately 0.50 Å and a short wave-length limit of 0.26 Å. The x-ray dosages were measured by the use of a standard open-air ionization chamber according to the design developed at the National Bureau of Standards.[1] The ionization current was determined by means of a circuit for amplification of direct currents using the FP-54 pliotron.

The seeds (germ side up) were always placed upon a thin layer of cheesecloth which eliminated the effect of back secondary scattering. The ionization chamber could be easily placed in the equivalent position of the seeds for measurement of the dosage. In general the maximum error in the dosage measurements was less than 5 per cent. For a majority of the treatments the seeds were placed about 13 cm from the anode. The dosage then received was approximately 500 "r" units per min. for 6 milliamperes plate current at 48 kv. d. c.

The treated seeds were germinated in one of two ways. For comparing root and shoot elongation at the very early stages the seeds were placed in moist cloths or blotters in germinating chambers. For the study of delayed killing and seedling growth, the seeds were planted in sand contained in small flats placed on a clinostat in the greenhouse. With doses of less than 1,000 r units no differences were detected between treated seed and controls. Dosages from 1,000 to 20,000 r units showed increasing reduction in the rate of elongation with an occasional plant killed at the higher dosages. Treatments above 40,000 r units resulted in delayed killing, the percentage of killed plants increasing with the dosage. From 60,000 to 100,000 r units the *percentage of germination remained unimpaired but all plants died in the seedling stage.* An attempt was made to find the dosage that would inhibit germination. One lot given 1,000,000 r units germinated 39 per cent, and another lot given 2,400,000 r units failed to germinate at all. *It is estimated, therefore, that doses of approximately 2,000,000 Roentgens completely inhibit germination.*

At the time of emergence of the plumule in plants subjected to a lethal dose of 60,000 r units the rate of elongation is only slightly less than that of plants from untreated seeds. The rate decreases rapidly and elongation ceases altogether in about a week, at which time there will usually be a thick crumpled first leaf showing. After elongation has stopped the seedling remains green for about another week before dying. The stage at which the seedlings die shows that growth involving cell division has taken place and that the observed germination has not been simply cell expansion.

[1] L. S. Taylor and G. Singer, *Radiology*, 15: 637, 1930.

The plants from x-rayed seeds were grown under several widely different environments to determine whether it was possible to prolong their existence. These included various temperatures and light and dark chambers, but without exception death occurred in a similar manner under all conditions.

Something suggestive of delayed killing may be observed in old seed. In samples of maize that have been kept until they are nearly dead there will often be seeds that will sprout but die in the seedling stage. The delayed death of old seed, however, is not as clear cut as in x-rayed material and appears to differ in its nature. A few observations were made on the seedling stages of maize seeds injured by heat at 60°–65° C. In this material nothing in the nature of delayed death was found. All seeds that germinated in the sense of producing root and shoot continued to grow with no indication of "delayed killing."

Root tip material of maize seedlings from x-rayed seeds, old seeds and heat-treated seeds were examined cytologically by Dr. A. E. Longley. He found the number of dividing cells in all treated material to be much less than in controls. In the x-rayed material all mitoses were abnormal, many figures exhibiting pycnosis. The abnormality varied in degree from divisions with lagging chromosomes to those in which the chromatin was an undifferentiated amorphous mass. Dividing cells in the old material, though less numerous than in the x-rayed material, showed normal mitosis. In the heat-treated seeds there were dead areas and adjacent to these areas the cell divisions were normal.

These cytological findings are not in complete agreement with those reported in other species.

Working with *Crepis tectorum* L. Navashin[2] found chromosome aberrations in the root tips of plants from old seed that were strikingly like those in x-rayed material. In the later work Shkvarnikov and Navashin,[3] using high temperature to hasten the aging process, got similar results. The illustrations in their publication suggest that seeds of Crepis subjected to 25,000 r units show something similar to the delayed killing in maize.

Peto[4] reports an increasing mutation rate in maize with increasing age and in barley with high temperature, using chromosomal derangements as a measure of mutation.

Our failure to get abnormal mitoses with heat may be associated with the method used, but the absence of chromosomal abnormalities in the old seed examined by Longley is an outstanding difference.

[2] M. Navashin, *Nature*, 131: 435, 1933.

[3] P. K. Shkvarnikov and M. S. Navashin, *Jour. de Biol.*, 4: 25–38. 1935. (Russian with English summary.)

[4] F. H. Peto, *Canadian Jour. of Research*, 9: 261–264, 1933.

From our limited cytological study it appears that in maize the primary effect of lethal dosages of x-rays is to derange the mechanism of mitosis to an extent that prevents the orderly separation of the chromosomes. Since cell division and growth continues for a time in the absence of normal mitosis it would appear that the cessation of cell division is an indirect effect of x-rays. In the absence of properly distributed chromatin, cells may divide, but the process can proceed but a short time. With aging or heat our experiments indicate that the mechanism of mitosis is unaffected and death appears to follow a more general failure of protoplasmic activity.

Aside from cytological considerations, if delayed killing proves to be peculiar to x-ray treatments, it will indicate a fundamental difference between the operation of x-rays and other lethal agencies.

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SOME PROPERTIES OF BAKED SOAPSTONES

HIGH-GRADE soapstone has been mined for centuries in China for the manufacture of carved utensils, ornaments, images of various forms, etc. According to Professor Jung Keng, of Yenching University, an expert in Chinese archeology, Chinese carvers of the Ming Dynasty (as far back as A.D. 1600, if not earlier than this) already knew that after it has been baked to certain temperature, soapstone will undergo a great change in its hardness and so they made use of this very property to prevent the particular characters and figures that they had carved on soapstone from being ground off by others.

Nowadays the uses of soapstone are many and varied and its suitability for certain uses depends closely on its physical and chemical properties. The authors present the following results of their tests on twenty-one samples of soapstone, collected from Hopeh, Shantung, Kiangsu, Chekiang and Fukien provinces, China.

I. *Volume resistivity of soapstones as a function of their baking temperatures.* By means of both the galvanometer and electrometer methods, as used by Curtis,[1] the volume of resistivity of 21 samples were measured, most of which are given in Fig. 1. It is seen that samples Nos. 1, 2, 20 and 21 are very suitable for electrical insulation at high temperatures. The rest either have been cracked into pieces at comparatively low baking temperatures or have much lower values of volume resistivity.

[1] H. L. Curtis, "Insulating Properties of Solid Dielectrics," *Bulletin of the Bureau of Standards*, 11: 359–383, 1913.

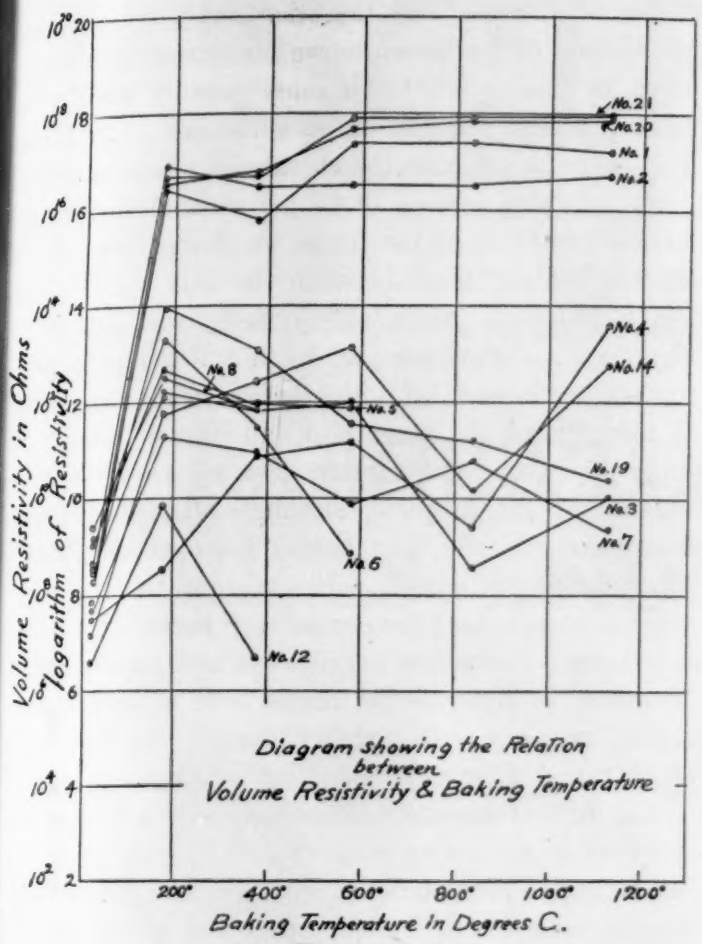

FIG. 1.

Samples Nos. 1, 2, 20 and 21 were again baked up to as high as 1870° C. and their corresponding volume resistivities computed and listed in Table 1.

TABLE 1

Sample	Sample baked up to 1130° C.	Sample baked up to 1350° C.	Sample baked up to 1700° C.	Sample baked up to 1870° C.
No. 1	1.30×10^{17}	1.15×10^{17}	9.6×10^{16}	1.0×10^{17}
" 2	4.37×10^{16}	5.56×10^{16}	3.25×10^{16}	1.25×10^{16}
" 20	6.85×10^{17}	2.30×10^{17}	2.10×10^{17}	1.68×10^{17}
" 21	7.50×10^{17}	6.78×10^{16}	5.81×10^{16}	5.40×10^{16}

It is evident that on further baking beyond 1130° C. the volume resistivity of these four samples decreases gradually.

II. *The compressive strength of soapstones.* The four samples mentioned above were tested by a laboratory oil press and showed the result given in Table 2.

TABLE 2

Sample	Compressive strength in pounds per square inch	
	Raw state	After baking up to 1130° C.
No. 1	2,500–3,300 lbs.	14,000 lbs.
" 2	2,000–2,500 "	10,000 lbs.
" 20	4,500–6,500 "	over 16,000 lbs.
" 21	2,000–2,800 "	over 16,000 lbs.

III. *Action of acids and alkalies on soapstones.* Raw and baked soapstones of these four samples have shown no noticeable sign of slight chemical change after being dipped for five minutes into concentrated hydrochloric, nitric and sulfuric acids and sodium hydroxide.

IV. *Hardness of raw and baked soapstones.* These four samples are approximately of the same order of hardness as that of quartz, which is about 6. In consequence of this great change in its hardness, from 1 to 6, baked soapstone can not be machined by ordinary shop tools.

V. *Change of colors at different baking temperatures.* See Table 3.

TABLE 3

Sample	At 22° C.	180° C.	380° C.	580° C.	840° C.	1130° C.
No.1	grayish white	gray	dark gray	dark gray	white	white
" 2	light pink	gray	dark gray	dark gray	white	white
" 20	grayish white	gray	dark gray	dark gray	white	white
" 21	grayish white	gray	dark gray	dark gray	white	white

VI. *Linear shrinkage and loss of weight after being baked.* After being baked to a temperature of 850° C.: (a) The average linear shrinkage of these samples is about 1 per cent.; (b) the loss of weight is about 5 per cent.

These results, together with others, will be published in detail in the forthcoming issues of the *Journal of the Chinese Chemical Society.*

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE DEMONSTRATION OF INTACT NERVOUS SYSTEMS OF INVERTEBRATES BY MACERATION OF WHOLE ANIMALS

CORNWELL[1] has demonstrated the nervous systems of vertebrates by the maceration of whole animals with 30 per cent. nitric acid. We were curious to know whether this maceration method would work satisfactorily upon invertebrates and whether or not the logic used for the explanation of this phenomenon could be verified. The present report records the results obtained when using the nitric acid maceration method upon invertebrates having nervous systems

[1] W. S. Cornwell, SCIENCE, 79: 162–163, 1934.

that are difficult to demonstrate by the conventional dissecting methods. Representatives from three phyla were used: (1) a mollusk, *Loligo pealei*; (2) two arthropods, *Libinia emarginata* and *Limulus polyphemus*; and (3) an echinoderm, *Asterias forbesi*. After killing the animal, it was placed in a 30 per cent. solution of nitric acid.

For the arthropods an immersion of 24 hours was sufficient to remove the inorganic salts of the exoskeleton completely and macerate the underlying tissues except the nervous tissue. The animal was removed from the acid bath and placed in a dish containing water. By cutting with a fine pair of scissors along the lateral, anterior and posterior margins of the carapace, this much softened structure was easily removed. The underlying tissues were then removed to expose the entire ventral nervous system. A fine camel's hair brush was found to be very useful in removing bits of tissue lying around the ganglia and nerve fibers extending into the appendages. Placing the dish containing the specimen under a gentle stream of water was effective in removing the remaining debris and washing out the acid.

With *Loligo* and *Asterias* a period of 12 hours in the macerating fluid was sufficient to soften the tissues adequately. With *Asterias* one needed only to pick away the tube feet and surrounding tissues with a pair of forceps in order to demonstrate the superficial nervous system. The method is a simple and efficient way of making class demonstrations. Moreover, a permanent preparation may be made by mounting the exposed systems in a suitable glycerine-jelly mass.

Cornwell[2] has suggested the presence of the myelin sheath, with its fatty properties, in the vertebrates as the explanation for the resistance to maceration, as shown by the central and peripheral nervous systems. The disappearance of a greater share of the sympathetic system he attributes to the fact that it is not entirely myelinated. This reasoning can not be used to account for the effects upon the invertebrates, for it is generally agreed that in the invertebrates and even in the cyclostomes a myelin sheath is not typically developed and is only characteristic of the adults of higher vertebrates. However, in addition to the nucleated sheath known as the neurilemma investing the nerve fibers of the invertebrates, there is present after treatment with osmic acid a deep staining layer between the outer sheath and the axis cylinder in some forms, *e.g., Palaemon*. Although this does not necessarily indicate the presence of fat, Friedländer[3] suggested that this sheath is similar to the myelin sheath in the vertebrates. On the other hand, the electrical stimulation of molluscan nerve fibers reveals a breakdown in conduction much more rapidly than when using the same stimulation on vertebrate nerve fibers. This perhaps indicates the absence of a myelin sheath.

By applying acetone or 95 per cent. alcohol to isolated nerve fibers of the forms we studied, we did not observe a clear space between the axis cylinder and the neurilemma which, if present, would indicate myelination. Furthermore, when a 2 per cent. solution of acetic acid, of which a few drops are placed at the edge of the cover slip and drawn through by filter paper, the preparation does not show the persistence of fat droplets, although albumin granules disappear optically. In *Loligo, Limulus* and *Libinia* the staining of isolated nerve fibers with Sudan III did not reveal the presence of any region of fat-like substance between the neurilemma and axis cylinder. However, in *Asterias* the fibrils have a more or less central position, with a rather densely staining region surrounding them. This region is composed of epithelial cells of mesodermal origin which may possibly serve as a protective covering. Apparently, in the invertebrates there must be some inherent property of the nervous tissue which resists the action of the macerating fluid, since the fibers are generally without a heavy protective sheath.

We are continuing our investigations on a variety of forms, along the following lines: a determination of the time necessary for the maceration process; a cytological study of the nervous elements of these representatives, using some of the more recent techniques; a chemical determination of the nervous tissue components.

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[2] *Ibid.*

[3] B. Friedländer, *Mitth. zool. Sta. Neapel*, Bd. 9, Heft 2, S. 205–265, 1889.

BOOKS RECEIVED

BROWN, PERCY. *American Martyrs to Science through the Roentgen Rays.* Pp. xv + 276. 55 figures. Thomas. $3.50.

Collected Reprints, 1935. Illustrated. Woods Hole Oceanographic Institution.

HUBBELL, THEODORE H. *A Monographic Revision of the Genus Ceuthophilus. (Orthoptera, Gryllacrididae, Rhaphidophorinae).* Vol. II, No. 1 of Biological Science Series. Pp. 551. 2 figures. 38 plates. University of Florida. $3.75.

LEMON, HARVEY B. *Cosmic Rays Thus Far.* Pp. xviii + 128. Illustrated. Norton. $2.00.

MACMILLAN, WILLIAM D. *Theoretical Mechanics: Dynamics of Rigid Bodies.* Pp. xiii + 478. 82 figures. McGraw-Hill. $6.00.

RYLE, JOHN A. *The Aims and Methods of Medical Science.* Pp. 44. Cambridge University Press, Macmillan. $0.75.